DECLARATION

I, Maria Meiers, of 5 Brushwood Place, Hornsby, New South Wales 2077, Australia, do solemnly and sincerely declare:

1. That I am well acquainted with both the English and German languages, and

2. That the attached document is a true and correct translation of the specification accompanying the application for patent made in International Application No. PCT/DE94/01077 filed on 17th September, 1994.

AND I make this declaration conscientiously believing the statement contained herein to be true in every particular.

DATED this 12th day of June 1995

[Signature]
Switching installation for distributing electric power protected against arc interference

The invention relates to a switching installation protected against arc interference according to the preamble of claim 1.

Interference arcs occur for example in low voltage switching installations when a direct electric connection is made between the conductors or between conductor and earth, without a metallic short circuit being present, for example, when insulation is interrupted or when an operating errors occur. The live parts of differing potentials are bridged by means of a plasma column.

The surroundings of the arc are heated up rapidly and with such force by the very high plasma temperature, resulting in a pressure build-up in the switching installation which reaches its maximum after just 15 to 20 ms. Frequently, the compression stress is larger than the mechanical stability of the doors and separating wall of the switch cabinets. These parts are then blown off and moved at high velocity.

If people are present, the hot gases and glowing particles can cause severe burns. The radiation emitted from the plasma column can also lead to damage by flashing.

In CH 676 174 an arc detector device is disclosed which detects an arc in a switching installation by using a light guide sensor. The arc detector extends across several switch cells. An error message is transmitted independent of the source of the interference arc.

It is a disadvantage of this arrangement, that, when an interference arc error occurs, no selective switching-off can result, for example to secure a supply to consumers by means of a reserve power supply.
From this, it is also inconclusive, how interference arcs can be quenched below a certain time, for example 5 ms, in such a way that selective short circuit protection is not impaired.

A fast short circuiter is known from the journal Elektrotechnik 1982, volume 6, pp 23-27, in particular figure 5 and the patent application HU 169 992 which is supposed to quench an interference arc in less than 5 ms. In figure 6 of the above mentioned journal, a mains with a reserve power supply is illustrated in which the application of the short circuiter is described. Each time an interference arc occurs, for example during the first supply, the short circuiter is operated.

Although people are thereby reliably protected, in areas where a very high supply reliability is required, it is not acceptable that entire supply areas have to manage without power supply for longer periods of time due to, for example, spurious releases. Such releases may occur with ambient light coupling or interference arcs in front of the feeder switch.

Numerous guide-lines, patent literature, reports, other publications and state of the art technology relating to the topic of "interference arc protection" are known.

Despite numerous propositions to resolve the problem, a negative development has taken place with respect to the occurrence of accidents since the sixties.

It is therefore the object of the present invention to find an economically acceptable solution to increase the safety of a switching installation in such a way that interference arcs are recognised securely and quickly and the effects of interference arcs can be avoided without the danger of spurious releases and jeopardising people
or parts of the installation. In particular, the selectivity should be maintained when short circuits and overcurrents occur and the reliability of power supply should be high.

The object of the invention is solved by means of the characterising features of claim 1, whereby particularly advantageous further developments of the invention are characterised in the sub-claims.

The invention and further embodiments and improvements of the invention and further advantages are described and explained by means of an example illustrated in the accompanying drawings.

In the drawings:
Fig. 1 shows a perspective view of a section of a low voltage switching installation,

Fig. 2 shows a unipolar flow diagram of the switching installation illustrated in Fig. 1,

Fig. 3 shows a side view of one of the interior compartments of the individual fields,

Fig. 4 shows a front view of an elementary diagram of the power busbar and instrument arrangement,

Fig. 5 shows a display of the conductor plate to which the sensors are connected,

Fig. 6 shows a display of the sensor connection,
Fig. 7 shows a further display of the connection,

Fig. 8 shows a display of a central processor,
Fig. 9 shows a display of a decentralised processor,

Fig. 10 shows an elementary diagram of the short circuiter,

Fig. 11 shows an elementary diagram of the installation at a busbar arrangement in a low voltage switching installation,

Fig. 12 shows a perspective view of the installation at a busbar arrangement in a low voltage switching installation,

Fig. 13 shows a display of a busbar arrangement with the outgoing busbar and Hall sensors in frontal view,

Fig. 14 shows the busbar arrangement of Fig. 3 in side view,

Fig. 15 shows a display of a component part Z of the busbar arrangement of Fig. 4,

Fig. 16 shows a display of a busbar arrangement with the outgoing busbar and further Hall sensors,

Fig. 17 shows the busbar arrangement of Fig. 6 in side view,

Fig. 18 shows a first arrangement of the light guide sensor to three power busbars,

Fig. 19 shows a second arrangement of the light guide sensor to three power busbars,

Fig. 20 shows a third arrangement of the light guide sensor to three power busbars,
Fig. 21 shows an arrangement of the light guide sensor to three power busbars and vertically connected busbars and

Fig. 22 shows a further arrangement of the light guide sensor to three power busbars and vertically connected busbars.

The switching installation 1 comprises a first feeder A, a second feeder B and a reserve feeder R, as shown in the accompanying flow diagram.

A reserve transformer is located behind the reserve feeder which takes over the supply by connecting a section switch if one of the two feeders A or B fails.

The switching installation 1 also comprises three power busbar sections SSA, SSR and SSB which can be fed by a feeder switch each EA, ER and EB. The power busbar sections SSA and SSR as well as SSR and SSB are connected to each other by section switches KA and KB.

A first outgoing switch AA is connected to the power busbar section SSA, whereby also several outgoings or outgoing switches can be present, for example, for feeding a sub-distributor.

Fig. 2 shows a section of four cabinets 11 to 14 of the switching installation 1, and Figs. 3 and 4 show further displays of these four cabinets 11 to 14.

The first cabinet 11 has the first outgoing switch AA. In the second cabinet 12 the first feeding switch EA and a short circuiter, which will be described in detail at a later stage, are arranged. The third cabinet 13 contains the section switch KA and the fourth cabinet the feeder switch ER of the reserve feeder R.
As shown in Fig. 4, the power busbars of feeder A extend into the upper area across at least three cabinets 11 to 13. Further outgoing switches can be arranged to the left of these power busbars when these are extended to the left, as indicated with broken lines.

The power busbars of the reserve feeder R are arranged in the middle section and in the third and fourth cabinet 13, 14 as well as to the right of these cabinets.

The switching installation is equipped with Hall sensors and light guide sensors for detecting interference arcs. The function of the sensors will be explained later on.

The light guide sensors serve the global (at least in the same operating areas independent from locations) detection of interference arcs, i.e. they indicate that an interference arc has occurred, while the Hall sensors detect the exact source of the interference arc.

The detection of interference arcs can occur for one switchboard section each. In this case, there are in total up to eight Hall sensors which are fed by means of screened signalling lines to an electronic detection device. The connection is made via a 25 polar D-sub socket or plug 16 which bears on a conductor plate 17, whereby the conductor plate 17 is located in an earthed sheet steel case below the cabinet lid or the distributing bars.

Up to three light guide sensors (LWL) 17, 18, 19 are arranged directly on the conductor plate, either fixed or pluggable, as shown in Fig. 5. In addition to the Hall sensors, one or several LWL loops are arranged in a switchboard section and logically connected to each other as "or".
The Hall sensors are connected parallel for each location in groups of two to three Hall sensors as "OR", which takes place in the electronic detection device, whereby the Hall sensors can be arranged for example in the space between two conductors or busbars as well as busbars and earthed parts of the installation.

There are up to eight arrangement locations in different operation areas of a switchboard section, such as a busbar distribution area, an instrument compartment or a connecting area. For example, one or two groups of Hall sensors can be located in up to 3 rail distributor areas. One or two groups of Hall sensors can then be arranged in up to two instrument compartments. A group of Hall sensors can be present in a connecting area.

In the electronic detection device or in a different signal processing station, the LWL compound signal is individually logically connected as "AND", in such a way, that different switching and protective devices such as a short circuiter, a power switch, a feeder switch or a section switch can react.

In the simplest case, a compound signal from an "OR" connection of the LWL sensors can occur with a compound signal from an "OR" connection of the Hall sensors. Optical transmitters, receivers and amplifiers for light guide sensors are integrated in the electronic detection device.

The logic function for the connection of the sensors and the output signals for the protective and switching devices are realised with GALs, PALs or EPROMs and can be altered by new programming.
The output signals for the protective and switching devices are supplied by galvanically separated semiconductor relays and applied at a 9 polar SUB-D socket 20.

The electronic detection device in which the logical connection of the sensor signals is also integrated, controls the respective interfaces of the protective and switching devices by means of the 9 polar D-Sub plug 20.

Details of the central or decentralised release will be explained by means of different solutions later on.

As shown in Figs. 3 and 4, eight groups of Hall sensors H1 to H8 are arranged in the different operating areas of the first two cabinets 11 and 12, whereby a group of two Hall sensors is formed.

The individual operating areas are separated from one another in a known manner by bulkhead walls and such like.

In the busbar distribution area of the cabinets 11 and 12, two groups of Hall sensors H1 and H2 are arranged between the horizontal power busbars in this area for the detection of interference arcs only.

In the instrument compartment of the first cabinet 11 a third and a fourth group of Hall sensors H3 and H4 are arranged in the area of the vertical connecting busbars, whereby the third group of Hall sensors H3 is located in the area of the vertical connecting busbars and the fourth group H4 in the area of the vertical outgoing busbars, i.e. in front or behind the outgoing switch.

The connecting section of the first cabinet 11 is equipped with a fifth group of Hall sensors H5 in the
area of the vertical outgoing busbars or in the area of the horizontal outgoing busbars.

A sixth and seventh group of Hall sensors H6 and H7 are arranged in the instrument compartment of the second cabinet 12, these being arranged in front and behind the feeder switch EA.

An eighth group of Hall sensors H8 is present in the connecting section serving the feeding.

These groups of Hall sensors H1 to H8 are, as previously explained, connected with the entire electronic detection device, which can be located in one of the two cabinets 11 or 12.

Additionally, three loops of LWL sensors L1, L2 and L3 are applied, each extending across several cabinets, as can be seen in Fig. 4.

The first LWL sensor L1 is arranged parallel to the power busbars in the area of the busbar distribution section of cabinets 11 and 12. The second LWL sensor L2 extends across both instrument sections of cabinets 11 and 12, transversely to the outgoing, feeding and connecting busbars. The third LWL sensor L3 extends across the connecting sections of cabinets 11 and 12.

Naturally, further cabinets can be equipped with sensors which are assigned to a further electronic detection device.

The exit switch AA, as shown in the switching installation of Fig. 3 is a power switch in the known manner, which has a switch-off time of 15 ms. The feeder
switch EA, also shown there, is also a power switch with a switch-off time of 30 ms. The short circuiter KS effects a metallic short circuit in at least less than 5 ms. The timings for the detection and processing of an interference arc are low with respect to the switch-off times of the switching devices, at least smaller than 5 ms.

The switching installation is connected to a network. The network should have such a high short circuit capacity that an interference arc has to be switched-off in at least 20 ms in order to avoid damage to the installation parts or nearby people.

As shown in Figs. 6 and 7, the sensors are connected in such a way that in response to the detection of an interference arc at a particular point, the appropriate elements, such as the cabinet, operating section or one or more of the live parts such as connecting busbars on the line side and outgoing busbars of different instruments, are released.

A compound signal is formed by means of an OR-connection resulting from the output signals of the individual LWL sensors L1, L2 and L3, as shown in Fig. 6. This compound signal is individually logically connected as "AND" to the output signals of the Hall sensor groups H1 to H8, whereby the Hall sensors H1a, H1b, which are arranged in pairs and form one group, are logically connected as "OR".

The compound signals X1 to X8 of the LWL and Hall sensor outputs are connected as follows with the different switching and protective devices, as shown in Fig. 7.
The control signal of the short circuiter KS, which is arranged in the low voltage switching installation, is formed by an OR connection of the signals X1 to X3 and X6.

The control signal of the feeder switch EA, which is arranged in the low voltage switching installation, is also formed by an OR connection of the signals X1 to X3 and X6.

The control signal of the outgoing switch EA, which is arranged in the low voltage switching installation, is formed by an OR connection of the signals X4 and X5.

The control signal of the section switch KS, which is arranged in the low voltage switching installation, is formed by an OR connection of the signals X7 and X8.

The control signal of the medium voltage switch MS-LS, which is arranged outside of the low voltage switching installation, is also formed by an OR connection of the signals X7 and X8.

The control signal of the medium voltage short circuiter MS-KS, which is arranged outside of the low voltage switching installation, is also formed by an OR connection of the signals X7 and X8.

The operation mode is explained as follows by means of three error cases.

The first case displays an interference arc LBS in the power busbar area, as indicated in Fig. 1, for example in the power busbar area between two power busbars in one of the two cabinets 11 or 12 (response of the Hall sensors H1 or H2 and LWL sensors L1), in the instrument
compartment between the connecting busbars of the outgoing switch AA on the line side (response of the Hall sensors H3 and LWL sensor L2) or in the instrument compartment between the connecting busbars of the feeder switch EA connected to the power busbars (response of the Hall sensors H6 and LWL sensor L2).

In this case, a compound signal is produced by one of the LWL sensors L1 or L2 which is connected to a Hall sensor signal of one of the Hall sensors H1, H2, H3, H6 as AND, whereby the short circuiter KS is then activated and the feeder switch EA is switched off. The interference arc is quenched in less than 5 ms, whereby the short circuit current is interrupted by the feeder switch EA within 30 ms.

In the second case, an interference arc LBA develops in the outgoing section of the outgoing switch AA, whereby the interference arc occurs either in the instrument compartment of the outgoing switch AA (response of the Hall sensor H4 and the LWL sensor L2) or in the connecting section of the first cabinet 11 (response of the Hall sensor H5 and the LWL sensor L3). In this case, a switch-off impulse is transmitted to the outgoing switch AA quenching the interference arc within 15 ms, ie. below the permissible 20 ms.

In the next case example, an interference arc LBE occurs in the line side area of the feeder switch, for example in the connecting section of the second cabinet 12 (response of the Hall sensors H8 and the LWL sensor L3) or in the instrument compartment of the feeder switch EA (response of the Hall sensor H7 and the LWL sensor L2). A switching device which is arranged upstream and a further short circuiter are activated, for example a medium voltage switch MS-LS and a short circuiter MS-KS.
arranged downstream at the medium voltage line side, as illustrated in Fig. 4.

The short circuiter MS-KS quenches the interference arc after just 5 ms. The metallic short circuit produced by this short circuiter is then switched off by the medium voltage switch MS-LS. Furthermore, the power circuit KA is activated by the electronic detection device, so that the consumers connected to the power busbar sections SSA can be further supplied by the reserve feeder R, without interrupting for example manufacturing processes in the chemical industry.

Alternatively, in the first case (LBS), only one control signal to the short circuiter can occur. The individual feeding branches are selectively switched off by the short circuiter which comes as a standard equipment.

Alternatively, in the second case (LBA), a control signal can be transmitted to the short circuiter KS and the feeder switch EA, eventually also transmitted to the outgoing switch AA.

Alternatively, in the third case (LBE), only one control signal can be transmitted to the medium voltage switch MS-LS or also additionally or exclusively to the short circuiter KS.

A plurality of sensors and therefore several detection units are required in complex low voltage switching installations. The information transmission in order to release switching processes can occur centrally or in a decentralised manner, as will be explained with Figures 8 and 9.
Fig. 8 shows a section of a low voltage switching installation comprising switching cells, microcontrollers C arranged within the cells, LWL and Hall sensors connected to the microcontrollers, switching or protective devices such as power switches LS and short circuiter KS, which are directly connected to either the microcontrollers or with a central unit by means of control lines, whereby the individual microcontrollers and the central unit are connected by means of an optical data line, illustrated as a broken line.

The error which has occurred is detected in each switch cell and transmitted without decision to the central unit by means of the executing switching actions. A decision is made in the central unit via the executing switching actions dependent upon the actual switching status of the installation.

Only the switching-off of the power switch in the outgoing cells can occur autonomously in each cell since this decision can be exclusively derived from the criteria within the cell.

The signal transmission will occur via an optical data line, out of consideration for the EMV.

Fig. 9 shows a section of a low voltage switching installation with decentralised release of the switching instruments.

The individual switching cells display one logic unit each with semiconductor relays and sensors connected to this logic unit. A control line SL connects the individual logic units and the switching devices. The source of the detected error generates in each switching cell an output signal directly for the respective switching instrument. This signal is put into the control line by means of a semiconductor relay HR
and can release a corresponding trigger in the switching
device to be addressed.

Fig. 10 shows the short circuiter KS which can be designed in the known manner.
If an interference arc occurs, a high current IC is switched from an energy storage to a spool N for a very short time. As a result of the forces developing in the cup-like metal parts K1 and K2 by the induction current, a metallic short circuit is produced between the parts XR and YR which are to be short circuited.

The Hall sensors H1 to H8 will be further explained in the following, whereby reference signs are provided with an elevated comma.
The arrangement and operation mode will be explained by the following simple examples without direct reference to the preceding more complex examples.

As indicated in Fig. 11, two Hall sensors 1' are arranged between the power busbars 3' in the power busbar area 2' of a low voltage switching installation.

The signal produced by the Hall sensors 1' is fed to an evaluation switch 4', which is here not further explained, which processes the signal and controls a selectively operating switching or protective device 5' vertical to the power busbars 3', and in case of an interference arc or a different transverse error, reduces the effect of the interference arc by a fast contact gap.

It is also possible, to use a device that generates a short circuit which is harmless to the installation, instead of a switching device.
The Hall sensors 1' are omnipolar, digital Hall sensors 1' which change their switching status when a magnetic field parallel to the sensor surface reaches the range of action of the sensors. The Hall sensors 1' change their switching status independent from the direction of the magnetic field that acts upon them (north-south or south-north direction). If the sensors switch on, for example in a magnetic field which is directed north-south, when the magnetic connecting flux density falls short, for example by means of a magnetic field directed south-north, the hall sensors 1' are put back into their initial status. The Hall signal develops a rectangular course.

The Hall sensors 1' are arranged parallel with their surface and spaced at a distance d, preferably three centimetres, to the power busbars 3', as can be seen in Fig. 12.

The Hall sensors 1' are arranged such that they only change their switching status when a magnetic field runs parallel to the Y-Z-plane of the system of coordinates illustrated in Fig. 12.

An interference arc is displayed in the two upper power busbars 3'. The magnetic field B caused by the faulty current runs essentially parallel to the X-Y-plane, whereby an outgoing signal is produced by Hall sensor 1'.

Short circuit currents in the power busbars as a result of bolted short circuits are not meant to be detected by the arc detector. The short circuit current marked with IK in the uppermost power busbar 3' produces a magnetic field running in the Y and X direction and in the Hall sensor’s range of action but does not cause an outgoing signal.
Fig. 13 shows the arrangement of the Hall sensors S1, S2 for the detection of an interference arc on the main busbars 6', without the operating current of the vertically arranged outgoing busbars 7' generating a Hall signal, whereby the Hall sensors are only indicated.

Referring in particular to the detailed display Z in Fig. 14, each of both Hall sensors S1, S2 is arranged within the distance h1, i.e. between the power busbars, and positioned such that the side walls of each are within the interval b1 corresponding to the thickness of the power busbars of the outgoing bars 7'. Also, the side walls of the Hall sensors S1, S2 correspond to the operating direction.

The distance 1 between the outgoing busbar and the Hall sensor S1 or S2 should be as small as possible. This positioning ensures that the magnetic field generated by the operating current in a vertical power busbar system penetrates the Hall sensor S1 or S2 vertically in any case and does not generate a Hall signal. At the same time, the magnetic field which is generated by the operating current by means of the horizontal power busbar system, also penetrates the sensor surface essentially vertically. The tangential magnetic field component, acting parallel to the sensor surface, runs vertical to the operating direction of the sensor and therefore cannot initiate the generating of a Hall signal.

The positioning of the sensors according to Figs. 13 and 15 does not generate a Hall signal due to the flow of an operating current in the horizontal and vertical power busbar system. A Hall signal is only generated when an interference arc occurs. The tangential component of the
magnetic field generated by the interference arc in the horizontal busbar system runs parallel to the operating direction of the sensors and exceeds its connecting flux density.

With the arrangement in Fig. 13, only one interference arc in the horizontal bar system can be detected. Therefore, it is advantageous to use sensor technology in the vertical area also. Hall sensors S3 and S4 are arranged analogously to the Hall sensors S1, S2 between the outgoing busbars 7', as illustrated in Fig. 17.

In the following, the LWL sensors L1 to L8 will be further explained, whereby reference signs are provided with a double elevated comma. The arrangement and mode of action is explained by means of simple examples in the following without direct reference to the preceding complex examples. The device shown in the Figs. 18 to 22 is arranged in the busbar section of a low voltage switching installation which is jeopardised by interference arcs, in order to supervise the occurrence of an interference arc.

The device 1" comprises a light guide sensor 2", an electronic switch 3" with a luminous diode with constant light beam of defined wave length at the beginning of the light guide sensor 1" and a receiver at the end of the light guide sensor 1". This light beam is used for supervising the protective device. Hereby, the degradation of construction elements and the mechanical damage of the light guide sensor are avoided. If an interference arc occurs in the busbar section, its light is coupled into the light guide sensor through its casing. This additional coupling of light results in an elevation of the light level received by an evaluation
switch connection. The electronic switch connection 3" produces a voltage proportional to the light level.

After exceeding a switch level which can be adjusted at the evaluation switching connection, a signal is produced by a selectively operating protective device 4", which can be used for switching-off part of the switching installation damaged by interference arcs or of a different suitable device. The evaluation switching connection is located in an area that is not jeopardised by interference arcs.

The light guide sensor 2" comprises a gradient fibre with a nucleus of circa 0.06 mm, a casing of 0.12 mm and a second casing or primary protection consisting of a coloured acrylate with a diameter of circa 0.25 mm of a green or blue colouring. The light guide sensor 2" has favourable qualities with respect to the light coupling by interference arcs and also with respect to its interference immunity towards ambient light. The mechanical stability and the required bending radii are also achieved. The optical attenuation of the light guide sensor is 3 to 4 Db/km at 850 nm or 0.5 to 1.5 Db/km at 1300 nm.

Light guide sensors with a blue casing provide a safe detection behaviour for larger currents with a low probability of a spurious release, whereas light guide sensors with a green casing still fulfill the requirements for a fast and safe detection also for smaller currents, for example IK= 4 kA. Preferably, the light guide sensors with a green casing are to be used in the area of smaller currents, while the light guide sensors with a blue casing are useful for larger currents.

The light guide sensor with the blue casing is preferably used in mains distribution in low voltage switching
installations due to the larger short circuit capacity provided and the larger faulty currents associated therewith. A further aspect is that protective technology used in mains distribution has to operate reliably, since a spurious release can have serious consequences for connected devices. Therefore, preference should be given to the less accident prone blue casing, as there is a lower probability of a spurious release, and if an interference arc error occurs, sufficient radiation capacity is available in any case.

With the use of commercially available light guide sensors with a coloured casing, which has been provided so far for distinguishing from other light guide sensors only in the signal transmission, additional filters are not necessary.

In order to ensure a high installation safety, the reliable functioning of the detecting switching connection is necessary. It has to be ensured that the detection device responds safely to the smallest interference arc power and nevertheless maintains a sufficient interference level and working level. If the distance between the interference level and the working level is too small, a spurious release can result in the switching-off of important consumers. On the other hand, if this distance is too big, it can result in a non-response and a destruction of the installation.

The maximum interference level in this embodiment example is between 30 and 50 percent of the working level in order to ensure sufficient safety towards interference light. A further increase of the interference level would increase the safety from interference light, but would at the same time decrease the detection of interference arcs since the switching threshold would eventually not be reached. Furthermore, the detection times increase, so
that a detection within a few milliseconds would no
longer occur.

The light guide sensor is arranged at a distance of about
50 mm from the busbars and is vertically centred on the
busbar system. The distance can be decreased. The light
guide sensor should not be arranged directly on the
busbars since the shading effect of the busbars is the
biggest there.

It is also advantageous, to arrange the light guide
sensor at a distance corresponding to the distance of the
busbars.

Fig. 18 shows an arrangement with three power busbars 5", 6"
and 7", and a light guide sensor 2" which is arranged
vertically to the latter and is wrapped around all three
power busbars without touching them. If arcing occurs
between two power busbars, it can be considered as a
line-like radiation source. The light guide sensor 2" is
then located parallel to the interference arc. The
radiation is emitted radial symmetrically and hits the
light guide sensor at a straight or slightly bent angle.
The incident light is coupled inwardly as a result of the
microscopic curvatures of the light guide sensor axis. At
its maximum level, the radiation striking the surface of
the light guide sensor casing is high in this arrangement
relative to ambient light, so that detection occurs in
the development stage of the interference arc, i.e. in
less than 5 ms. The filter effect of the casing
additionally enhances this behaviour.

The curvature radii of the light guide sensor here and in
the following examples are relatively high in the area of
light coupling, for example larger than 40 mm, so that
ambient light is only weakly coupled inwardly.
The light guide sensor 2" can also be wrapped around each power busbar 5 several times and also be arranged across the full extent or essential parts thereof. An interference arc is then always very close to the light guide sensor, so that sufficient light is coupled in during the early development stage, in order to facilitate a particularly fast detection. However, there is an increased risk of destroying the light guide sensor when arcing occurs, but this would take place after the detection.

A further arrangement of the light guide sensor is shown in Fig. 20. Here, the light guide sensor is arranged to zig-zag across the front of the power busbars, although a similar arrangement behind the power busbars is also possible. The light guide sensor 2" runs parallel to the power busbars over large areas at the same distance, so that a large detection area is safely covered with a relatively small light guide sensor length.

If connecting busbars are present, as illustrated in Fig. 21, or also field busbars, the same light guide sensor can be wrapped around these vertical busbars.

Fig. 22 shows an arrangement where the light guide sensor 2" can also be wrapped between power taps. The development of an interference arc is the most likely in this area.

Further criteria such as power increase or voltage drop can be taken into consideration in order to avoid spurious release in the known manner.

In a switching installation, in particular in a low voltage switching, each operating area, such as busbar
area, instrument compartment and connecting area, can be provided with a separate light guide sensor.

The arrangement of the light guide sensor can be on bulkhead plates or other plane installation parts provided close to the power busbars, whereby the securing of the light guide sensor can occur by means of gluing or securing elements such as fastening eyelets or spacers. Busbar fasteners can be used in main distribution busbar systems for the fastening, for example fasteners as shown and described in DE-PS 40 13 312. The light guide sensor can then be guided through specially provided borings. In main distribution busbar systems, it is of particular advantage that the light guide sensor is arranged longitudinally to the power busbars centred in the area between the busbars.

It is particularly advantageous in the connecting instrument compartment that the light guide sensor is arranged transversely to the busbars as a loop or helix, for example on a bulkhead plate. A longitudinal installation is preferred with incoming busbars longer than 300 mm.

The light guide sensor is advantageously arranged in close proximity or around live parts, whereby a direct touching of the live parts or a closely fitted arrangement is not excluded, but is also interpreted as part of the term "in close proximity".

The Hall sensors in these examples are sensors reacting to magnetic fields and are independent from current and voltage, unlike magnet sensitive sensors such as current and voltage transformers.
The switching cabinet housing made of tin or metal forms a barrier for external magnetic fields which otherwise could be coupled into the Hall sensors.

It is particularly advantageous to protect Hall sensors with epoxy resin.
Patent Claims

1. Switching installation for distributing electric power protected against arc interference, characterised in that Hall sensors (H1 to H8) and additionally light guide sensors (L1 to L3) are available as sensors, whereby the Hall sensors (H1 to H8) are connected to the light guide sensors (L1 to L3) via a logical AND.

2. Switching installation according to claim 1, characterised in that a short circuiter (KS) is activated, which, in case of an interference arc, switches on a high current (IC) from an energy storage to a spool (N) for a very short time, producing a metallic short circuit between the parts (XR and YR) which are to be short circuited, as a result of the forces developing in the cup-like metal parts (K1 and K2) which are under a vacuum, by the induction current.

3. Switching installation according to one of the preceding claims, characterised in that a short circuiter (KS) is activated when the section switch arranged upstream of the interference arc source, has a higher switch-off time than the permissible arc existence time.

4. Switching installation according to one of the preceding claims, characterised in that the Hall sensors (H1 to H8) are omnipolar, digital Hall sensors which change their switching status when a magnetic field parallel to the sensor surface reaches the sensors' range of action.

5. Switching installation according to one of the preceding claims, characterised in that the light guide sensors (L1 to L3) have a blue casing, whereby the light of the interference arc is coupled through this casing.
6. Switching installation according to one of the preceding claims, characterised in that the Hall sensors (H1 to H8) are arranged to detect interference arcs locally, and are arranged in individual switching cells (11 to 13), operating areas such as a busbar distribution area, instrument compartment or connecting area, and operating sections such as feeding or outgoing busbars of instruments, wherein these Hall sensors (H1 to H8) are logically connected to an evaluation and control unit which is commonly assigned to at least one group of sensors, such that the evaluation and control unit controls switching actions of the switching and protective devices (EA, AA, KS, KA) located in the instrument compartments.
Fig. 3

Fig. 4
Fig. 8

Fig. 9

ERSATZBLATT
Fig. 22